TRANSLATION

World Intellectual Property Organization

International Secretariat

International Application Disclosed in Accordance with Patent Cooperation Treaty

(51) International Patent Classification[4]:
B32B 5/18, 5/24, B29C 39/12
B60N 1/00 //B29K 75:00
B29L 31:58

(11) International Disclosure No.: WO 89/08550 (A1)

(43) International Disclosure Date: September 21, 1989

(21) International Patent Application No.: PCT/JP89/00265

(22) International Application Date: March 10, 1989

(31) Priority Claim No.: 63-54996
(32) Priority Claim Date: March 10, 1988
(33) Priority Claim Country: JP

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(81) Designated Countries
AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), KR, LU (European patent), NL (European patent), SE (European patent), US.

Attached Disclosure Documents: International Search Report

(54) Title: INTEGRAL FOAM MANUFACTURED ARTICLE HAVING A THREE-LAYER LAMINATE SKIN

(57) Abstract: An integral foam manufactured article composed of a substantially closed three-layer laminate skin that has been formed to a desired final shape, and a core foam which has been obtained from an expandable mixture such as a reactive polyurethane dope injected into the skin as a liquid or cream, does not pass through the skin whatsoever, and is integrally bonded to the inner face of the skin. The three-layer laminate skin is composed of a gas-permeable surface fabric such as a woven or knit fabric; a thin intermediate foam layer such as a thin layer of bonded polyurethane foam on the inner face of the surface fabric; and a barrier film with numerous small vent holes that allow gases to pass through but not the expandable mixture, such as a polyvinyl chloride film or a polyurethane film, which film is bonded to the inner face of the thin layer. The barrier film has an excellent smoothness which ensures good flow of the expandable mixture, prevents any of the expandable mixture from penetrating to the thin intermediate foam layer and the surface fabric, and enables the formation of a core foam which is uniform and has a soft feel throughout.

SPECIFICATION

Integral Foam Manufactured Article Having a Three-Layer Laminate Skin

Technical Field

The present invention relates to an integral foam manufactured article having a three-layer laminate skin. More specifically, it relates to an integral foam manufactured article enclosed within a three-layer laminate skin composed of a gas-permeable surface fabric on the outermost side, an intermediate slab foam, and a barrier film on the innermost side.

Background Art

A known method for producing integral foam manufactured articles involves:

a) preparing a gas-permeable surface fabric,
b) fashioning this fabric into a substantially closed shape corresponding to the final contours of the desired finished product, and
c) injecting a liquid expandable mixture such as a liquid polyurethane mixture into this closed shape, foaming and expanding this mixture in situ and causing it integrally unite with the inner face of the surface fabric.

In this method, the surface fabric must be gas-permeable to allow the release of gases generated during foaming and air that is initially present at the interior of the surface fabric.

However, gas-permeable surface fabrics have numerous drawbacks. For example, the liquid expandable mixture that has been injected onto the inner face of the fabric penetrates into the surface fabric itself and bleeds out to the surface of the fabric, where it cures to form hardened spots or regions. This compromises the appearance of the final product and hardens the feel of the foam manufactured article, lowering the quality of the article. French Patent No. 2,470,566 (January 13, 1984; to Société Industrielle Bertrand Fauré) discloses one method, shown schematically in attached FIG. 5, for overcoming these problems. In this method, a gas-permeable surface fabric 1 made of natural or synthetic fibers and a thin layer 2 of synthetic foam bonded thereto make up a skin material. A reactive polyurethane dope having a high catalytic activity is directly introduced into the skin as the reaction is beginning but while the dope is still in a fluid state, and is foamed and expanded to form a core foam 3. In this French patent, it is claimed that the core foam 3 penetrates slightly into the thin foam layer 2 to form what is referred to as a "surface layer," providing in this way a strong bond between the core 3 and the thin layer 2. At the same time, the thin layer 2 remains gas permeable and the "surface layer" does not reach the surface fabric 1, so regions of local hardening do not form.

According to the above French patent, the "surface layer" is due to the fact that, as the injected mixture changes rapidly from a liquid to a cream, it penetrates the thin foam layer 2 only "surfacially" and forms a "hardened layer" which has hardened sufficiently to ensure a good bond between the core foam 3 and the thin foam layer 2.

The French patent thus states that problems observed in integral foam manufactured articles obtained by prior-art direct injection processes, such as bleeding of the expandable mixture from the surface fabric, and the hard feel and poor appearance of the resulting article, can be resolved in this way.

However, the existence of the hardened "surface layer" between the core foam and the thin foam layer in manufactured articles according to this French patent do in fact confer a hard and unpleasant feel when touching or pushing against the outside surface of such articles during actual use.

Another problem is that the injected cream-like expandable mixture passes through portions of the thin foam layer 2, increasing flow resistance by the injected substance and thereby lowering its flow properties. Hence, the teachings of this French patent are particularly unsuitable for the production of thin foam manufactured articles because expandable material injected in a thin or narrow space will have difficulty flowing therethrough and will fail to circulate through the entire article, resulting in defective portions where the desired foam body thickness is not achieved.

Furthermore, because the injected expandable material is subject to a larger flow resistance in relatively thin spaces, sufficient foaming and expansion does not occur in the region near the place of injection, resulting in an overfilled state. High densification in this area increases the hardness, giving a non-uniformly expanded article of non-uniform flexibility.

Disclosure of the Invention

Accordingly, one object of the invention is to provide an integral foam manufactured article which is free of local hardened areas over the entire surface of the final article and which has a uniformly soft and pleasant feel.

Another object of the invention is to provide an integral foam manufactured article which is formed with a liquid or creamy expandable composition having unimpaired flow properties and in which a predetermined amount of foam is properly distributed over the entire final article.

Yet another object of the invention is to provide an integral foam manufactured article which has a relatively thin profile and which moreover has the desired thickness in all areas and a substantially uniform degree of softness.

These and other objects are achieved by preparing a three-layer skin laminate skin material made of, on the outermost side, a gas-permeable surface fabric, an intermediate slab foam such as a thin polyurethane foam adhesively or otherwise bonded to the inner face of the surface fabric and, on the innermost side, a barrier film such as a polyurethane film or polyvinyl chloride film with numerous small vent holes that is adhesively or otherwise bonded to the inner face of the slab foam; forming the three-layer laminate skin material into a closed shape corresponding to the final contours of the desired final manufactured article, such as a headrest or an armrest; directly injecting the liquid or cream-like expandable mixture into this shaped skin material; and forming a core foam which is integrally bonded to the inner face of the barrier film.

The barrier film used in the invention should be a material which has a good smoothness that promotes good flow by the injected expandable mixture and which has a strong adhesion to the cured core foam. The use of a polyurethane film or a polyvinyl

chloride film is preferred. The barrier film also has formed therein numerous vent holes which are sufficiently small to prevent the expandable mixture from entering the intermediate slab foam but allow gases that evolve from the foam material to pass through the intermediate slab layer and the gas-permeable surface fabric.

The expandable mixture used in the invention is most preferably a reactive polyurethane composition which is in the form of a liquid or a cream at the time of injection.

The invention has the distinctive advantage of completely blocking entry of the expandable composition into the intermediate slab foam by providing on the innermost side a barrier film which allows gases to pass through but does not allow passage of the expandable composition. Hence, no hardened layer whatsoever is allowed to form at the interface between the core foam and the slab foam. Therefore, when the integral foam manufactured articles of the invention are touched from the outside, the soft, pleasant feel of the core foam can be directly enjoyed. Unlike manufactured articles according to the French patent, there is no sensation in the inventive articles of the unpleasant presence of a hard layer between the surface fabric and the core foam.

Likewise, according to the present invention, the excellent smoothness of the barrier film on the innermost side allows the injected expandable composition to exhibit much better flow than when it must flow directly on the slab foam. The expandable liquid or cream can thus enter with sufficient ease a narrow or thin space without being impeded in any way, enabling the production of foam articles in which foam of the desired thickness is properly distributed throughout the manufactured article. Moreover, because the injected expandable mixture has good flow properties, it rapidly reaches all areas within the article before the reaction proceeds very far. Foaming and expansion thus take place uniformly and substantially at the same time throughout all areas of the product, giving a manufactured article in which the degree of expansion and the foam hardness are substantially uniform throughout.

Brief Description of the Drawings

FIG. 1 is an enlarged partial cross-sectional view of the three-layer laminate skin material used to produce integral foam manufactured articles according to the invention.

FIG. 2 is a partially cutaway perspective view showing an armrest serving as one embodiment of a relatively thin integral foam manufactured article according to the invention.

FIG. 3 is a graph of the results of comparative tests on manufactured articles according to the invention ("with film") and prior-art articles ("without film"). The horizontal axis represents the distance from the point of injection reached by the expandable mixture by the time foaming and expansion end, and the vertical axis represents the hardness of the foam at various distances.

FIG. 4 is a perspective view of the skin material pipe used in these comparative tests, with one end of the pipe shown cut away.

FIG. 5 is a partial cross-sectional view illustrating an integral foam manufactured article according to the prior art.

Best Mode for Carrying Out the Invention

Embodiments of the invention are described below in detail while referring to the attached diagrams.

FIG. 1 shows an enlarged partial sectional view of the three-layer laminate skin material used in the invention. This skin material 10 has a gas-permeable surface fabric 11 such as knit or woven fabric. Slab foam 13 such as soft polyurethane foam is bonded to the inner face of the surface fabric at an interface 14. The slab foam 13 acts to release gases during the subsequently described expansion of the core foam so as to give the final product a soft surface feel. The slab foam 13 preferably has a thickness of several millimeters or more. At the inner face of the slab foam 13, a barrier film 15 provided with numerous small vent holes 17 for releasing gas is bonded at an interface 16 therebetween.

Preferred examples of the barrier film 15 include polyurethane films having a thickness of about 40 to 100 microns and polyvinyl chloride films having a thickness of 50 to 500 microns. These films have very small vent holes 17 formed therein of a size that allows gases to pass through but does not allow passage of the cream-like or liquid expandable mixture (e.g., reactive polyurethane dope). In cases where the volume of core foam is large, so that a large amount of gas evolves during foaming, it is desirable for the vent holes 17 to be formed in a correspondingly large number.

As will be explained subsequently in conjunction with the graph in FIG. 3, this barrier film may be a material which has a good smoothness that promotes good flow by the injected expandable dope and which has a strong adhesion to the expanded polyurethane.

The three-layer laminate skin material 10 of the invention is pre-formed into a substantially closed shape which corresponds to the external contours of the desired final product, following which the expandable mixture such as expandable polyurethane dope is directly injected into the closed shape to form the integral foam manufactured article.

FIG. 2 is a partially cutaway perspective view of an armrest serving as one embodiment of this type of article. Here, the three-layer laminate skin material is composed of a surface fabric 11, a slab foam 13 bonded to the inner side thereof as a gas-permeable backing layer, and a barrier film 15 having small vent holes which is bonded to the inner side of the slab foam. This skin material is formed by a process such as sewing or welding into a hollow shape corresponding to the external contours of the armrest. The expandable mixture is injected as a liquid or cream into this shaped skin material, and is foamed and expanded in situ, giving the core foam 18. Injection of this core foam 18 is carried out by inserting a suitable injector nozzle (not shown) at a point such as that represented by the reference numeral 19, and injecting in this way a predetermined amount of, for example, liquid or creamy reactive polyurethane dope. When the nozzle is subsequently withdrawn from the injection point 19, the hole seals itself under the elastic recovery forces of the surface fabric proper. It is desirable to place the injection point at a position on the final product that will be as inconspicuous as possible.

The expanded core foam 18 bonds strongly to the barrier film, so separation of the layers does not readily arise in normal use of the manufactured article.

Table 1 shows the test results obtained for the bond strength between the core foam and the barrier film. The three-layer laminate skin material used in these tests was a

jersey cloth available under the trade name Polychlal*, the slab foam was a soft polyurethane foam having a thickness of 2 mm, and the barrier film (with small pinholes) was the polyurethane film or polyvinyl chloride film shown in Table 1.

Table 1

(Values given in the table are the failing load**)

	Type of barrier film (thickness)		
	Polyurethane (100·m)	Polyvinyl chloride (470 μm)	
		Surface treated*	Untreated
Test 1	0.55[2]	0.54[1]	0.30[1]
Test 2	0.60[2]	0.50[1]	0.15[1]
Test 3	0.62[2]	0.60[2]	0.31[1]
Test 4	0.57[2]	0.56[2]	0.25[1]
Test 5	0.64[2]	0.58[2]	0.21[1]
Average	0.60	0.56	0.24

Notes:

*Film surface treated with acrylic primer.

**Failing load units are kg/25 mm (90° peel).

[1] Numerical data bearing the superscript "1" are cases in which failure occurred at the interface between the barrier film and the core foam.

[2] Numerical data bearing the superscript "2" are cases in which the core foam itself failed rather than separation occurring at the interface.

As is apparent from these test results, the three-layer laminate skin material of the invention exhibits sufficiently strong adhesion with the core foam at the barrier film on the inner face thereof. A polyurethane film and a surface-treated polyvinyl chloride film were found to be especially preferable for the production of integral foam manufactured articles having very little tendency to delaminate. No indications that the injected expandable mixture had entered the slab foam through the small vent holes in the barrier film and formed a "hardened layer" were found in these cases.

Next, tests of the smoothness of the barrier film used in the present invention is explained while referring to FIGS. 3 and 4. A skin material in the form of a pipe like that shown in FIG. 4 which has an inside diameter of 30 mm and is closed at both ends was used in this test. Two types of pipes were prepared: one composed of the three-layer laminate skin material according to the present invention, and the other a control specimen which lacks a barrier film and is composed only of a surface fabric and a thin foam layer backing on the inner face thereof. In FIG. 4, which shows a pipe made of a three-layer laminate skin material according to the invention, the pipe is composed of a surface fabric 11, a 2 mm thick layer of slab foam 13, and a barrier film 15 according to the invention. The control specimen lacks this barrier film 15. Both types of pipe were furnished to tests in which a nozzle was inserted at a point 19 on the pipe surface and passed through the slab foam, and reactive polyurethane dope was injected into the interior. In each case, the distance reached by the dope in the direction of arrow A

* Translator's Note: Correct English spelling of this trade name is unconfirmed.

(indicated by the dashed line) as it foamed and expanded and the hardness of the polyurethane foam at various distances were measured.

FIG. 3 is a graph showing the results of these tests. The vertical axis represents the hardness of the polyurethane foam, as measured with an Asker type C durometer. The horizontal axis represents the distance (cm) reached as the dope foamed and expanded from the injection point 19. The dashed-line curve represents the measured data for the control, and the solid-line curve represents the measured data for the three-layer laminate skin material of the invention.

As is apparent from FIG. 3, foam articles in which the control (without barrier film) is used give rise to excessively hard foam near the injection point; the hardness decreases as one moves further away from the injection point, and the dope fails to advance beyond at most about 50 cm. By contrast, in foam articles which use the three-layer laminate skin material of the invention, when the same amount of dope is injected as in the control, the dope advances while foaming and expanding to a point about 20 cm (17%) further. Moreover, the resulting foam has a substantially uniform hardness over the entire length of the article and is soft. Thus, the present invention has the advantage that, particularly in thin manufactured articles, it provides an article which is more resilient or soft and exhibits a uniform hardness throughout.

Industrial Applicability

As explained above, in the present invention, by using a three-layer laminate skin material having a barrier film with small vent holes on the innermost side to produce integral foam manufactured articles, gases that evolve from the injected expandable mixture can be effectively released as in prior-art skin materials, in addition to which the flow of the injection mixture is vastly improved, enabling the mixture, which begins foaming immediately after injection, to undergo good expansion out to a long distance. This makes it possible to obtain integral foam manufactured articles having the desired thickness even when such injection is carried out in a narrow or thin space. This improvement in flow enables the use of integral foaming to manufacture thin articles which have until now been impossible to produce in this way with the prior art.

An even larger advantage provided by the barrier film-bearing skin material of this invention is that it prevents the core foam from penetrating into the slab foam backing layer and hardening, and thus completely prevents formation of an undesirable "hardened layer" at the interface which gives the manufactured article a strange or unpleasant surface feel. This allows the qualities of a flexible, luxurious surface fabric to be fully exploited, enabling integral foam articles endowed with a soft feel to be achieved. Moreover, it has been demonstrated that even without a "hardened layer," which was regarded as having a bonding function, the integral foam articles of the invention are reliable products that, on account of the strong adhesion between the barrier film and the core foam, undergo no delamination whatsoever.

Claims

1. An integral foam manufactured article comprising a three-layer laminate skin made of a gas-permeable surface fabric on the outermost side, a thin intermediate foam layer bonded to the inside thereof, and a barrier film with numerous small vent holes that is bonded to the inside of the thin layer, and comprising also a core foam obtained by forming the laminate skin to a shape corresponding to a desired final contour, injecting an expandable mixture in the form of a liquid or cream into the shaped skin, and integrally bonding the mixture to the barrier film; wherein no hardened layer whatsoever forms between the core foam and the thin intermediate foam layer.
2. The integral foam manufactured article of claim 1, wherein the gas-permeable surface fabric is a knit or woven fabric made of natural or synthetic fibers.
3. The integral foam manufactured article of claim 1, wherein the thin intermediate foam layer is soft polyurethane foam having a thickness of 2 to 10 mm.
4. The integral foam manufactured article of claim 1, wherein the barrier film is a polyurethane film or a polyvinyl chloride film.
5. The integral foam manufactured article of claim 4, wherein the barrier film is a polyvinyl chloride film that has been surface-treated to improve adhesion.
6. The integral foam manufactured article of claim 1, wherein the expandable mixture is a reactive polyurethane dope.
7. The integral foam manufactured article of claim 1, wherein the surface fabric is jersey cloth and has bonded to the inner face thereof as the thin intermediate slab foam layer a 2 mm thick layer of soft polyurethane foam, wherein said thin foam layer has bonded to the inner face thereof as the barrier film a polyurethane film with numerous small vent holes that do not allow the core foam-forming dope to pass through, and wherein polyurethane foam as the core foam is integrally bonded to the barrier film.
8. The integral foam manufactured article of claim 7, wherein the core foam has a small thickness.

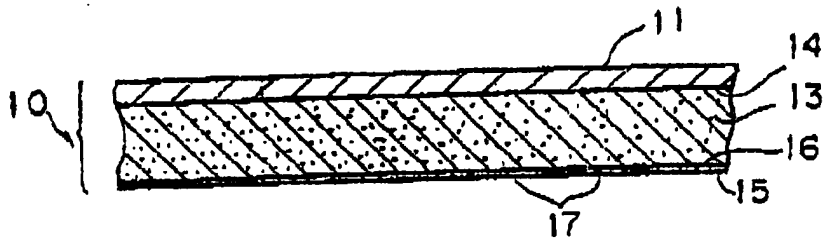

FIG. 1

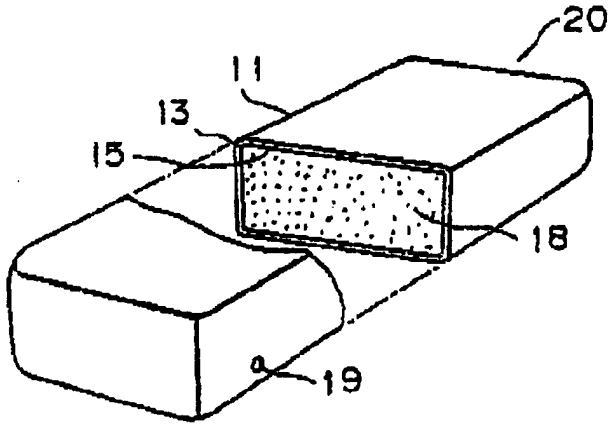

FIG. 2

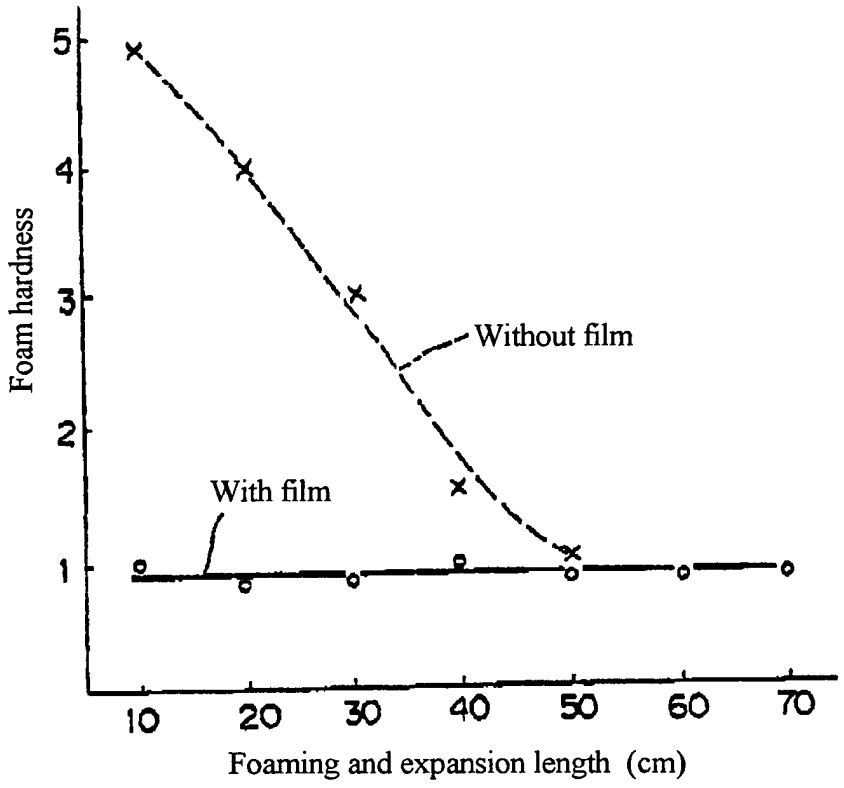

FIG. 3

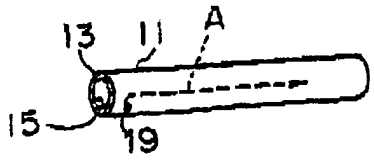

FIG. 4

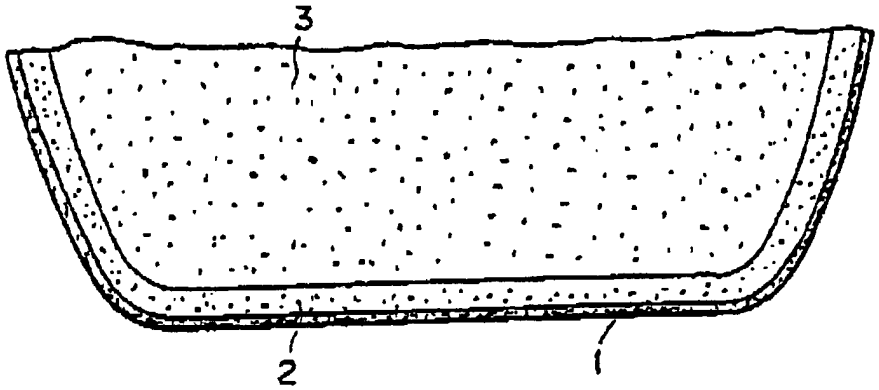

FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No PCT/JP89/00265

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl[4] B32B5/18, B32B5/24, B29C39/12, B60N1/00//B29K75:00, B29L31:58

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System [8]	Classification Symbols
IPC	B32B5/18, B32B5/24, B29C39/12, B60N1/00//B29K75:00, B29L31:58

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [9]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	FR, B, 2,470,566 (SOCIETE INDUSTRIELLE BERTRAND FAURE, S.A.) 13 January 1984 (13. 01. 84) Claim	1-8
A	JP, A, 50-140602 (Tokyo Sheet Kabushiki Kaisha) 11 November 1975 (11. 11. 75) Claim (Family: none)	1-8
A	JP, A, 61-293837 (Toyo Tire and Rubber Co., Ltd.) 24 December 1986 (24. 12. 86) Claim (Family: none)	1-8

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
May 22, 1989 (22. 05. 89)	June 5, 1989 (05. 06. 89)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	

Form PCT/ISA/210 (second sheet) (January 1985)

Translation: Language Services
F. Metreaud
December 21, 2002